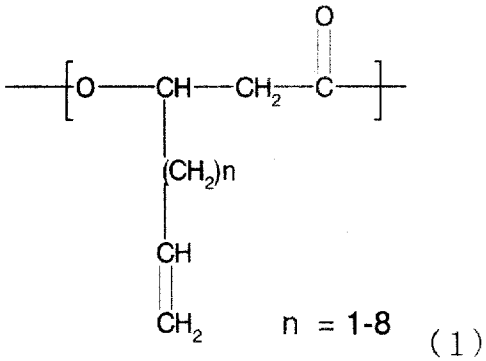
B. Claims

The following is a complete listing of the claims, and replaces all earlier versions and listings.

1. (Currently Amended) A polyhydroxy alkanoate copolymer ~~characterized in including~~comprising at least a 3-hydroxy-ω-alkenoic acid unit represented by a chemical formula (1) in a molecule, and simultaneously at least a 3-hydroxy-ω-alkanoic acid unit represented by a chemical formula (2) or a 3-hydroxy-ω-cyclohexylalkanoic acid unit represented by a chemical formula (3) in the molecule:

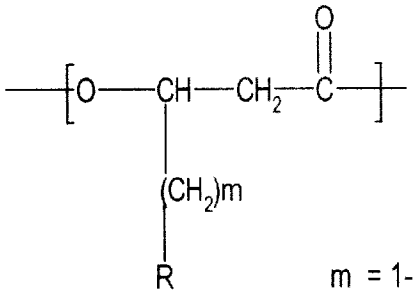
~~[Chemical Formula (1)]~~chemical formula (1)



(1)

in which n represents an integer selected within a range indicated in the chemical formula; and in case plural units are present, n is the same or different for each unit;

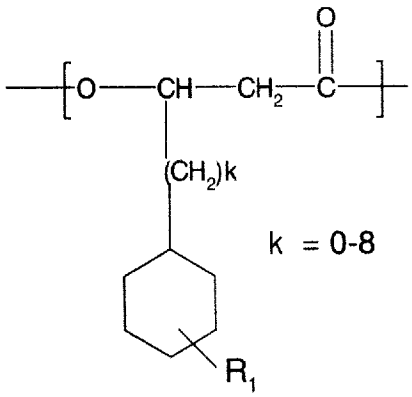
~~[Chemical Formula (2)]~~chemical formula (2)



(2)

in which m represents an integer selected within a range indicated in the chemical formula; R represents a residue having any of a phenyl structure or a thienyl structure; and in case plural units are present, m and R are the same or different for each unit;

~~[Chemical Formula (3)]~~chemical formula (3)



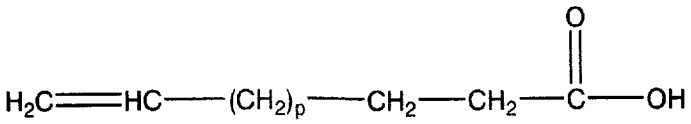
(3)

in which R_1 being a substituent on a cyclohexyl group represents a hydrogen atom, a CN group, a NO_2 group, a halogen atom, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; k represents an integer selected within a range indicated in the chemical formula; and in case plural units are present, R_1 and k may be the same or different for each unit.

wherein the polyhydroxy alkanoate copolymer is biosynthesized by using a

microorganism capable of producing it with at least an ω-alkenoic acid represented by a chemical formula (24) and at least a compound represented by a chemical formula (25) or at least an ω-cyclohexylalkanoic acid represented by a chemical formula (26) as starting materials:

chemical formula (24)

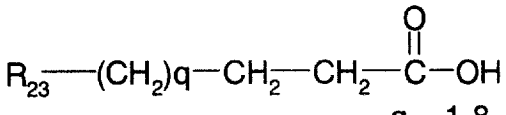


p = 1-8 (24)

,

in which p represents an integer selected within a range indicated in the chemical formula;

chemical formula (25)

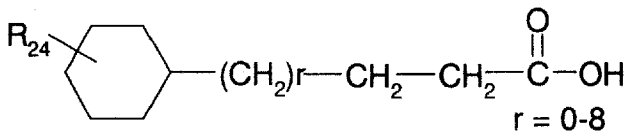


q = 1-8 (25)

,

in which q represents an integer selected within a range indicated in the chemical formula; and R_{23} is a residue having a phenyl structure or a thienyl structure; and

chemical formula (26)



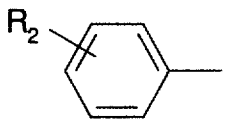
r = 0-8 (26)

in which R_{24} is a substituent on a cyclohexyl group and represents an H

atom, a CN group, a NO_2 group, a halogen atom, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and r represents an integer selected within a range indicated in the chemical formula.

2. (Currently Amended) The polyhydroxy alkanoate copolymer according to claim 1, wherein ~~R in the chemical formula (2) represents a~~the residue having a phenyl structure or a thienyl structure of R in the chemical formula (2) and of R_{23} in the chemical formula (25) is selected from the group consisting of chemical formulas (8), (9), (10), (11), (12), (13), (14), (15), (16), (17) and (18):

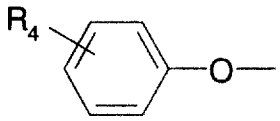
the chemical formula (8):



(8)

represents a group of ~~non-~~unsubstituted or substituted phenyl groups in which R_2, ~~a~~is a substituent on an aromatic ring and represents an H atom, ~~represents~~ a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $CH=CH_2$ group, a $COOR_3$ group (R_3 represents an H atom, a Na atom or a K atom), a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_2 is the same or different for each unit;

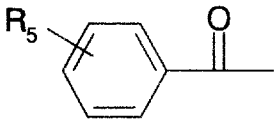
the chemical formula (9):



(9)

represents a group of ~~non-~~unsubstituted or substituted phenoxy groups in which R_4 ~~represents~~ is a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a SCH_3 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_4 may be the same or different for each unit;

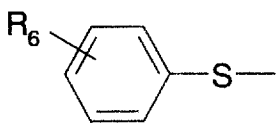
the chemical formula (10):



(10)

represents a group of ~~non-~~unsubstituted or substituted benzoyl groups in which R_5 ~~represents~~ is a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_5 may be the same or different for each unit;

the chemical formula (11)

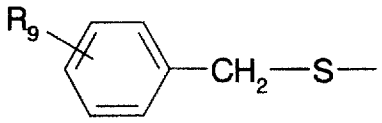


(11)

represents a group of substituted or ~~non-~~unsubstituted phenylsulfanyl groups in which R_6

~~represents~~ is a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_7$ group, a SO_2R_8 group (R_7 represents either one of H, Na, K, CH_3 and C_2H_5; and R_8 represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_6 may be the same or different for each unit;

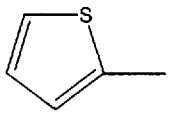
the chemical formula (12):



(12)

represents a group of substituted or ~~non-~~ unsubstituted (phenylmethyl)sulfanyl groups in which R_9 ~~represents~~ is a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_{10}$ group, a SO_2R_{11} group (R_{10} represents either one of H, Na, K, CH_3 and C_2H_5; and R_{11} represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_9 may be the same or different for each unit;

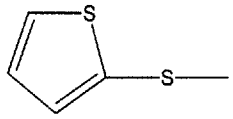
the chemical formula (13):



(13)

represents a 2-thienyl group;

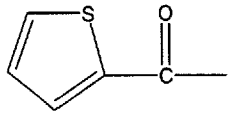
the chemical formula (14)



(14)

represents a 2-thienylsulfanyl group;

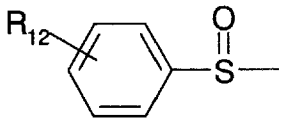
the chemical formula (15):



(15)

represents a 2-thienylcarbonyl group;

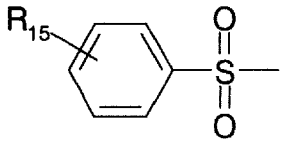
the chemical formula (16):



(16)

represents a group of substituted or non-substituted phenylsulfinyl groups in which R_{12} ~~represents~~ is a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_{13}$ group, a SO_2R_{14} group (R_{13} represents either one of H, Na, K, CH_3 and C_2H_5; and R_{14} represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_{12} may be the same or different for each unit;

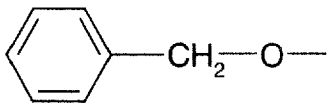
the chemical formula (17):



(17)

represents a group of substituted or non-substituted phenylsulfonyl groups in which R_{15} ~~represents~~ is a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_{16}$ group, a SO_2R_{17} group (R_{16} represents either one of H, Na, K, CH_3 and C_2H_5; and R_{17} represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_{15} may be the same or different for each unit; and

the chemical formula (18):



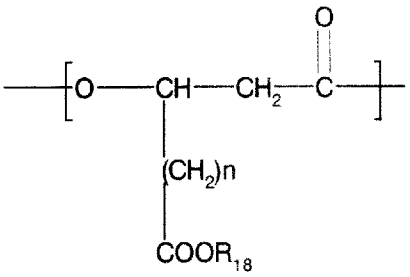
(18)

represents a (phenylmethyl)oxy group.

3. (Currently Amended) The polyhydroxy alkanoate copolymer according to claim 1, ~~wherein~~ which has a number-averaged molecular weight ~~is~~ within a range from 1000 to 1000000.

4. (Withdrawn) A polyhydroxy alkanoate copolymer characterized in including at least a 3-hydroxy-ω-carboxyalkanoic acid unit represented by a chemical

formula (19) or 3-hydroxy-ω-alkoxycarbonylalkanoic acid unit represented by a chemical formula (32) in a molecule, and simultaneously at least a 3-hydroxy-ω-alkanoic acid unit represented by a chemical formula (2) or a 3-hydroxy-ω-cyclohexylalkanoic acid unit represented by a chemical formula (3) in the molecule, [Chemical Formula (19)]



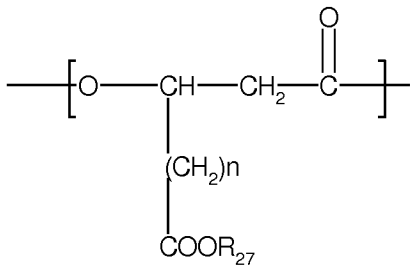
n = 1-8 (19)

in which n represents an integer selected within a range indicated in the chemical formula;

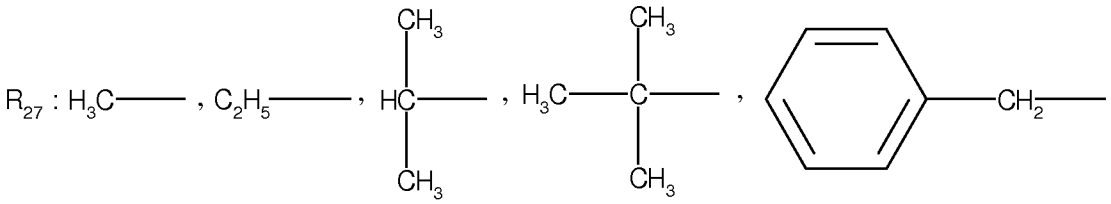
R_{18} represents an H atom, a Na atom or a K atom:

and in case plural units are present, n and R_{18} may be the same or different for each unit; and

[Chemical Formula (32)]



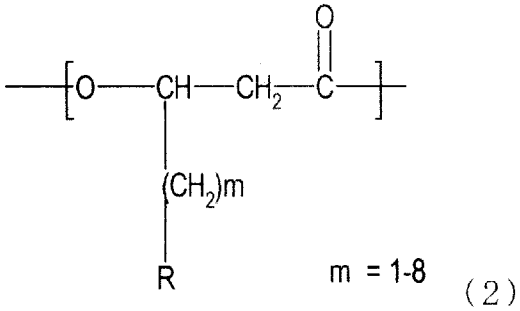
n = 1-8 (32)



in

which n represents an integer selected within a range indicated in the chemical formula; R_{27} represents any of residues indicated in the chemical formula; and in case plural units are present, n and R_{27} may be the same or different for each unit

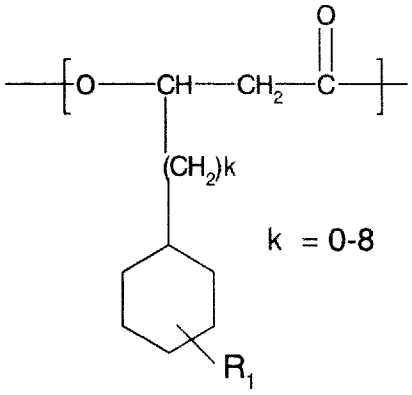
[Chemical Formula (2)]



(2)

in which m represents an integer selected within a range indicated in the chemical formula; R includes a residue having any of a phenyl structure or a thienyl structure; and in case plural units are present, m and R may be the same or different for each unit; and

[Chemical Formula (3)]

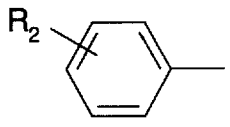


(3)

in which R_1 represents a substituent on a cyclohexyl group and represents an H atom, a CN group, a NO_2 group, a halogen atom, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; k represents an integer selected within a range indicated in the chemical formula; and in case plural units are present, R_1 and k are the same or different for each unit.

5. (Withdrawn) The polyhydroxy alkanoate copolymer according to claim 4, wherein R in the chemical formula (2), represents a residue having a phenyl structure or a thienyl structure selected from chemical formulas (8), (9), (10), (11), (12), (13), (14), (15), (16), (17), and (18):

the chemical formula (8):

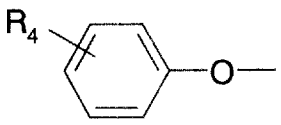


(8)

represents a group of non-substituted or substituted phenyl groups in which R_2 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a

NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $CH=CH_2$ group, a $COOR_3$ group (R_3 representing an H atom, a Na atom or a K atom), a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_2 is the same or different for each unit;

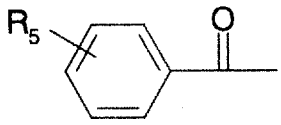
the chemical formula (9):



(9)

represents a group of non-substituted or substituted phenoxy groups in which R_4 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a SCH_3 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_4 is the same or different for each unit;

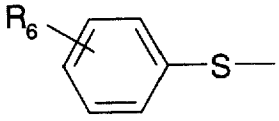
the chemical formula (10):



(10)

represents a group of non-substituted or substituted benzoyl groups in which R_5 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_5 is the same or different for each unit;

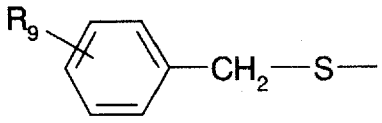
the chemical formula (11):



(11)

represents a group of substituted or non-substituted phenylsulfanyl groups in which R_6 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_7$ group, a SO_2R_8 group (R_7 represents either one of H, Na, K, CH_3 and C_2H_5; and R_8 represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_6 is the same or different for each unit;

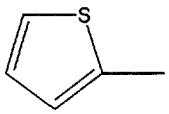
the chemical formula (12):



(12)

represents a group of substituted or non-substituted (phenylmethyl)sulfanyl groups in which R_9 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_{10}$ group, a SO_2R_{11} group (R_{10} represents either one of H, Na, K, CH_3 and C_2H_5; and R_{11} represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_9 is the same or different for each unit;

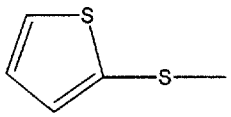
the chemical formula (13):



(13)

represents a 2-thienyl group;

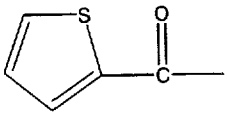
the chemical formula (14):



(14)

represents a 2-thienylsulfanyl group;

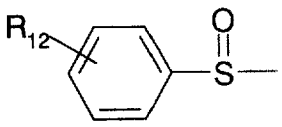
the chemical formula (15):



(15)

represents a 2-thienylcarbonyl group;

the chemical formula (16):

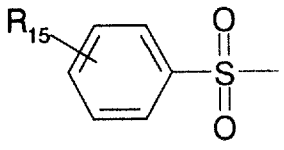


(16)

represents a group of substituted or non-substituted phenylsulfinyl groups in which R_{12} represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_{13}$ group, a SO_2R_{14} group (R_{13} represents either one of H, Na, K, CH_3 and C_2H_5; and R_{14} represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a

$(CH_3)_3$-C group; and in case plural units are present, R_{12} is the same or different for each unit;

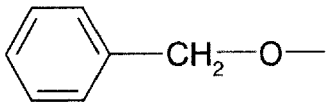
the chemical formula (17):



(17)

represents a group of substituted or non-substituted phenylsulfonyl groups in which R_{15} represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_{16}$ group, a SO_2R_{17} group (R_{16} represents either one of H, Na, K, CH_3 and C_2H_5; and R_{17} represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_{15} is the same or different for each unit; and

the chemical formula (18):



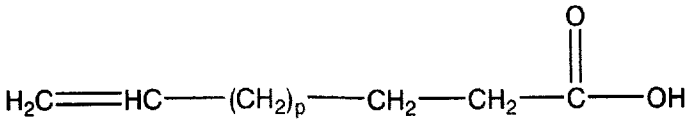
(18)

represents a (phenylmethyl)oxy group.

6. (Withdrawn) The polyhydroxy alkanoate copolymer according to claim 4, wherein a number-averaged molecular weight is within a range from 1000 to 1000000.

7. (Withdrawn) A method for producing a polyhydroxy alkanoate copolymer characterized in including a biosynthesis by a microorganism having an ability of producing a polyhydroxy alkanoate copolymer including at least a 3-hydroxy-ω-alkenoic acid unit represented by a chemical formula (1) in a molecule, and simultaneously at least a 3-hydroxy-ω-alkanoic acid unit represented by a chemical formula (2) or a 3-hydroxy-ω-cyclohexylalkanoic acid unit represented by a chemical formula (3) in the molecule, from at least an ω-alkenoic acid represented by a chemical formula (24) and at least a compound represented by a chemical formula (25) or at least an ω-cyclohexylalkanoic acid represented by a chemical formula (26) as starting materials:

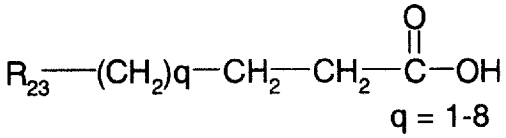
[Chemical Formula (24)]



p = 1-8 (24)

in which p represents an integer selected within a range indicated in the chemical formula;

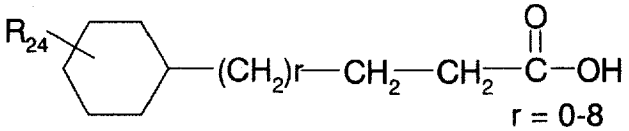
[Chemical Formula (25)]



q = 1-8 (25)

in which q represents an integer selected within a range indicated in the chemical formula; and R_{23} includes a residue having a phenyl structure or a thienyl structure;

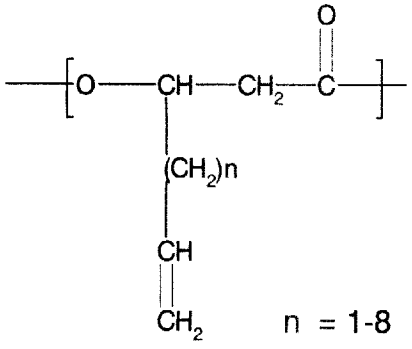
[Chemical Formula (26)]



(26)

in which R_{24} represents a substituent on a cyclohexyl group and represents an H atom, a CN group, a NO_2 group, a halogen atom, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and r represents an integer selected within a range indicated in the chemical formula;

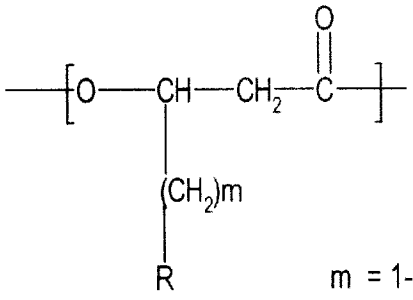
[Chemical Formula (1)]



(1)

in which n represents an integer selected within a range indicated in the chemical formula; and in case plural units are present, n is the same or different for each unit;

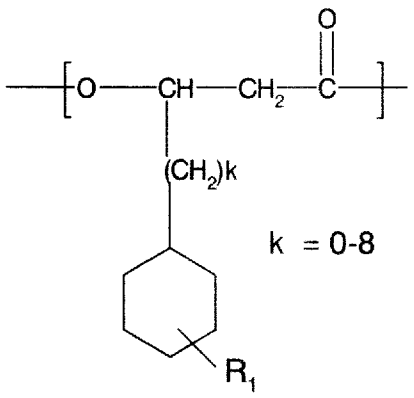
[Chemical Formula (2)]



(2)

in which m represents an integer selected within a range indicated in the chemical formula; R represents a residue having any of a phenyl structure or a thienyl structure; and in case plural units are present, m and R are the same or different for each unit; and

[Chemical Formula (3)]

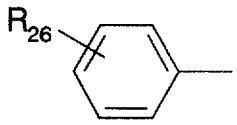


(3)

in which R_1 represents a substituent on a cyclohexyl group and represents an H atom, a CN group, a NO_2 group, a halogen atom, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; k represents an integer selected within a range indicated in the chemical formula; and in case plural units are present, R_1 and k are the same or different for each unit.

8. (Withdrawn) The method for producing a polyhydroxy alkanoate copolymer according to claim 7, wherein R_{23} in the chemical formula (25) and R in the chemical formula (2), each represents a residue having a phenyl structure or a thienyl structure, are selected from chemical formulas (31), (9), (10), (11), (12), (13), (14), (15), (16), (17) and (18):

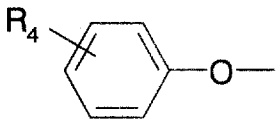
the chemical formula (31):



(31)

represents a group of substituted or non-substituted phenyl groups in which R_{26} represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $CH=CH_2$ group, a CF_3 group, a C_2F_5 group or a C_3F_7 group; and in case plural units are present, R_{26} is the same or different for each unit;

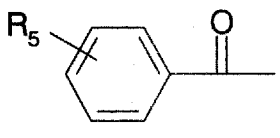
the chemical formula (9):



(9)

represents a group of non-substituted or substituted phenoxy groups in which R_4 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a SCH_3 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_4 is the same or different for each unit;

the chemical formula (10):

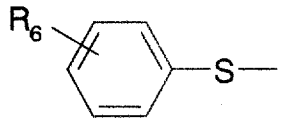


(10)

represents a group of non-substituted or substituted benzoyl groups in which R_5 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a

NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_5 is the same or different for each unit;

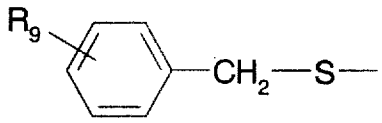
the chemical formula (11):



(11)

represents a group of substituted or non-substituted phenylsulfanyl groups in which R_6 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_7$ group, a SO_2R_8 group (R_7 representing either one of H, Na, K, CH_3 and C_2H_5; and R_8 representing either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_6 is the same or different for each unit;

the chemical formula (12):

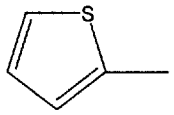


(12)

represents a group of substituted or non-substituted (phenylmethyl)sulfanyl groups in which R_9 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_{10}$ group, a SO_2R_{11} group (R_{10} representing either one of H, Na, K, CH_3 and C_2H_5; and R_{11} representing either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_9 is the same or different

for each unit;

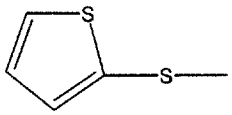
the chemical formula (13):



(13)

represents a 2-thienyl group;

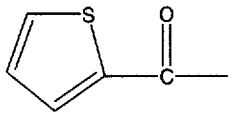
the chemical formula (14):



(14)

represents a 2-thienylsulfanyl group;

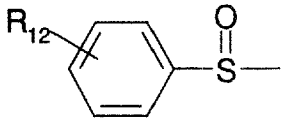
the chemical formula (15):



(15)

represents a 2-thienylcarbonyl group;

the chemical formula (16):

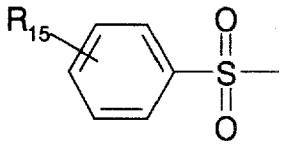


(16)

represents a group of substituted or non-substituted phenylsulfinyl groups in which R_{12} represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_{13}$ group, a SO_2R_{14} group (R_{13} representing either one of

H, Na, K, CH_3 and C_2H_5; and R_{14} representing either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_{12} is the same or different for each unit;

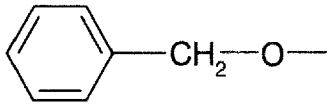
the chemical formula (17):



(17)

represents a group of substituted or non-substituted phenylsulfonyl groups in which R_{15} represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_{16}$ group, a SO_2R_{17} group (R_{16} representing either one of H, Na, K, CH_3 and C_2H_5; and R_{17} representing either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_{15} is the same or different for each unit; and

the chemical formula (18):



(18)

represents a (phenylmethyl)oxy group.

9. (Withdrawn) The method for producing a polyhydroxy alkanoate copolymer according to claim 7, wherein said microorganism is cultured in a culture

medium including at least an ω-alkenoic acid represented by the chemical formula (24) and at least a compound represented by the chemical formula (25) or at least an ω-cyclohexylalkanoic acid represented by the chemical formula (26).

10. (Withdrawn) The method for producing a polyhydroxy alkanoate copolymer according to claim 9, wherein said microorganism is cultured in a culture medium including, in addition to at least an ω-alkenoic acid represented by the chemical formula (24) and at least a compound represented by the chemical formula (25) or at least an ω-cyclohexylalkanoic acid represented by the chemical formula (26), at least one of a peptide, an yeast extract, an organic acid or a salt thereof, an amino acid or a salt thereof, a sugar, a linear alkanoic acid with 4 to 12 carbon atoms or a salt thereof.

11. (Withdrawn) The method for producing a polyhydroxy alkanoate copolymer according to claim 7, characterized in including a step of culturing said microorganism in a culture medium including at least an ω-alkenoic acid represented by the chemical formula (24) and at least a compound represented by the chemical formula (25) or at least an ω-cyclohexylalkanoic acid represented by the chemical formula (26), and recovering a polyhydroxy alkanoate copolymer including simultaneously at least a 3-hydroxy-ω-alkenoic acid unit represented by the chemical formula (1) and a 3-hydroxy-ω-alkanoic acid unit represented by the chemical formula (2) or a 3-hydroxy-ω-cyclohexylalkanoic acid unit represented by the chemical formula (3) in the molecule, produced by said microorganism, from cells of the microorganism.

12. (Withdrawn) The method for producing a polyhydroxy alkanoate copolymer according to claim 7, wherein said microorganism is a microorganism belonging to *Pseudomonas* genus.

13. (Withdrawn) The method for producing a polyhydroxy alkanoate copolymer according to claim 12, wherein said microorganism is at least one of *Pseudomonas cichorii* YN2 strain (FERM BP-7375), *Pseudomonas cichorii* H45 strain (FERM BP-7374), *Pseudomonas jessenii* P161 (FERM BP-7376) and `Pseudomonas putida P91 (FERM BP-7373).

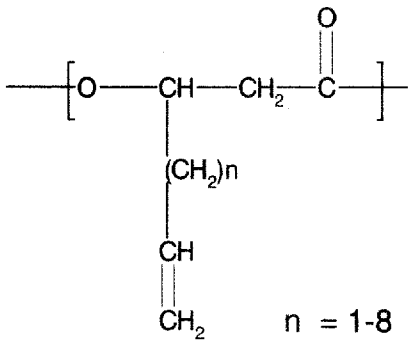
14. (Withdrawn) A method for producing a polyhydroxy alkanoate copolymer including at least a 3-hydroxy-ω-carboxyalkanoic acid unit represented by a chemical formula (19) in a molecule, and simultaneously at least a 3-hydroxy-ω-alkanoic acid unit represented by a chemical formula (2) or a 3-hydroxy-ω-cyclohexylalkanoic acid unit represented by a chemical formula (3) in the molecule comprising the steps of:

preparing a polyhydroxy alkanoate copolymer including at least a 3-hydroxy-ω-alkenoic acid unit represented by a chemical formula (1) in a molecule, and simultaneously at least a 3-hydroxy-ω-alkanoic acid unit represented by a chemical formula (2) or a 3-hydroxy-ω-cyclohexylalkanoic acid unit represented by a chemical formula (3) in the molecule as a starting material, and

oxidizing a double bond portion in the polyhydroxy alkanoate represented in

the chemical formula (1) thereby generating a polyhydroxy alkanoate copolymer including at least a 3-hydroxy-ω-carboxyalkanoic acid unit represented by a chemical formula (19) in a molecule, and simultaneously at least a 3-hydroxy-ω-alkanoic acid unit represented by a chemical formula (2) or a 3-hydroxy-ω-cyclohexylalkanoic acid unit represented by a chemical formula (3) in the molecule:

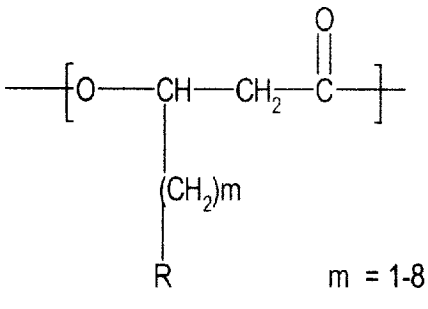
[Chemical Formula (1)]



(1)

in which n represents an integer selected within a range indicated in the chemical formula; and in case plural units are present, n is the same or different for each unit;

[Chemical Formula (2)]

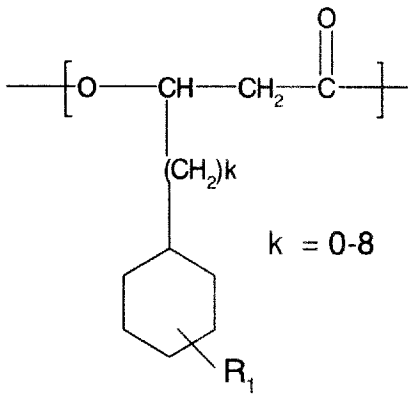


(2)

in which m represents an integer selected within a range indicated in the

chemical formula; R includes a residue having any of a phenyl structure and a thienyl structure; and in case plural units are present, m and R are the same or different for each unit;

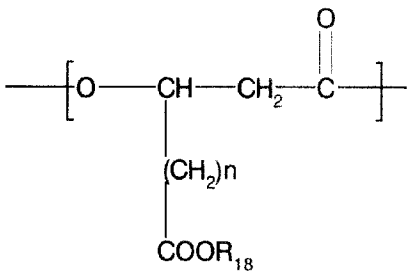
[Chemical Formula (3)]



(3)

in which R_1 represents a substituent on a cyclohexyl group selected from an H atom, a CN group, a NO_2 group, a halogen atom, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, and a C_3F_7 group; k represents an integer selected within a range indicated in the chemical formula; and in case plural units are present, R_1 and k are the same or different for each unit; and

[Chemical Formula (19)]

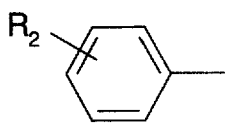


n = 1-8 (19)

in which n represents an integer selected within a range indicated in the chemical formula; R_{18} represents an H atom, a Na atom, or a K atom; and in case plural units are present, n and R_{18} are the same or different for each unit.

15. (Withdrawn) The method for producing a polyhydroxy alkanoate copolymer according to claim 14, wherein R in the chemical formula (2) represents a residue having a phenyl structure or a thienyl structure selected from chemical formulas (8), (9), (10), (11), (12), (13), (14), (15), (16), (17) and (18):

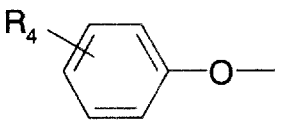
the chemical formula (8):



(8)

represents a group of non-substituted or substituted phenyl groups in which R_2 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $CH{=}CH_2$ group, a $COOR_3$ group (R_3 representing an H atom, a Na atom or a K atom), a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_2 is the same or different for each unit;

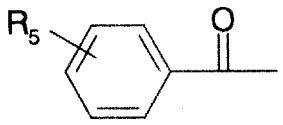
the chemical formula (9):



(9)

represents a group of non-substituted or substituted phenoxy groups in which R_4 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a SCH_3 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_4 is the same or different for each unit;

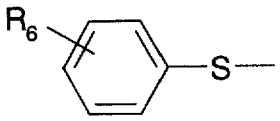
the chemical formula (10):



(10)

represents a group of non-substituted or substituted benzoyl groups in which R_5 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_5 is the same or different for each unit;

the chemical formula (11):

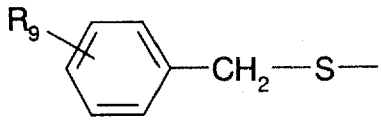


(11)

represents a group of substituted or non-substituted phenylsulfanyl groups in which R_6 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_7$ group, a SO_2R_8 group (R_7 represents either one of H, Na, K, CH_3 and C_2H_5; and R_8 represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a

$(CH_3)_3$-C group; and in case plural units are present, R_6 is the same or different for each unit;

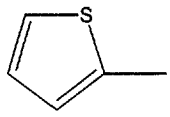
the chemical formula (12):



(12)

represents a group of substituted or non-substituted (phenylmethyl)sulfanyl groups in which R_9 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_{10}$ group, a SO_2R_{11} group (R_{10} represents either one of H, Na, K, CH_3 and C_2H_5; and R_{11} represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_9 is the same or different for each unit;

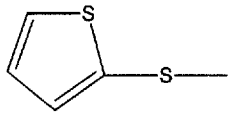
the chemical formula (13):



(13)

represents a 2-thienyl group;

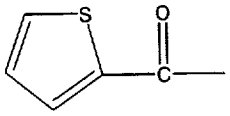
the chemical formula (14)



(14)

represents a 2-thienylsulfanyl group;

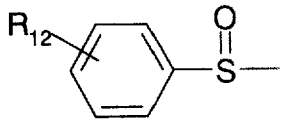
the chemical formula (15):



(15)

represents a 2-thienylcarbonyl group;

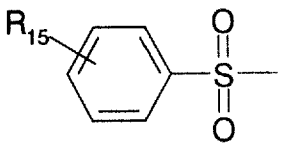
the chemical formula (16):



(16)

represents a group of substituted or non-substituted phenylsulfinyl groups in which R_{12} represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_{13}$ group, a SO_2R_{14} group (R_{13} represents either one of H, Na, K, CH_3 and C_2H_5; and R_{14} represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_{12} is the same or different for each unit;

the chemical formula (17):

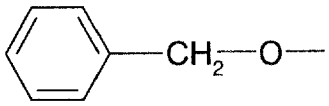


(17)

represents a group of substituted or non-substituted phenylsulfonyl groups in which R_{15} represents a substituent on an aromatic ring and represents an H atom, a

halogen atom, a CN group, a NO_2 group, a $COOR_{16}$ group, a SO_2R_{17} group (R_{16} represents either one of H, Na, K, CH_3 and C_2H_5; and R_{17} represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_{15} is the same or different for each unit;

the chemical formula (18):



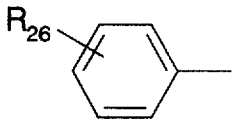
(18)

represents a (phenylmethyl)oxy group.

16. (Withdrawn) The method according to claim 14, wherein said starting material polyhydroxy alkanoate copolymer including at least a 3-hydroxy-ω-alkenoic acid unit represented by a chemical formula (1) in a molecule, and simultaneously at least a 3-hydroxy-ω-alkanoic acid unit represented by a chemical formula (2) or a 3-hydroxy-ω-cyclohexylalkanoic acid unit represented by a chemical formula (3) in the molecule, is produced by a method according to claim 7.

17. (Withdrawn) The method for producing a polyhydroxy alkanoate copolymer according to claim 16, wherein R in the chemical formula (2), representing a residue having a phenyl structure or a thienyl structure, is at least one of chemical formulas (31), (9), (10), (11), (12), (13), (14), (15), (16), (17) and (18):

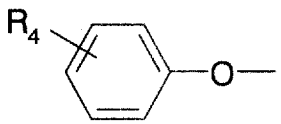
the chemical formula (31):



(31)

represents a group of substituted or non-substituted phenyl groups in which R_{26} represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $CH=CH_2$ group, a CF_3 group, a C_2F_5 group or a C_3F_7 group; and in case plural units are present, R_{26} is the same or different for each unit;

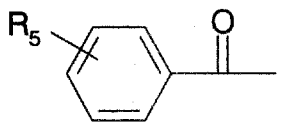
the chemical formula (9):



(9)

represents a group of non-substituted or substituted phenoxy groups in which R_4 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a SCH_3 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_4 is the same or different for each unit;

the chemical formula (10):

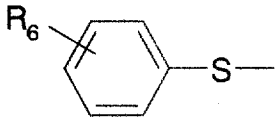


(10)

represents a group of non-substituted or substituted benzoyl groups in which

R_5 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_5 is the same or different for each unit;

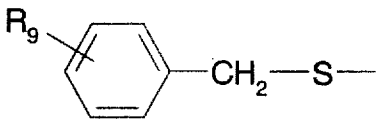
the chemical formula (11):



(11)

represents a group of substituted or non-substituted phenylsulfanyl groups in which R_6 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_7$ group, a SO_2R_8 group (R_7 representing either one of H, Na, K, CH_3 and C_2H_5; and R_8 representing either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_6 is the same or different for each unit;

the chemical formula (12):

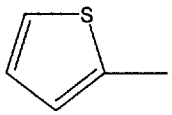


(12)

represents a group of substituted or non-substituted (phenylmethyl)sulfanyl groups in which R_9 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_{10}$ group, a SO_2R_{11} group (R_{10} representing either one of H, Na, K, CH_3 and C_2H_5; and R_{11} representing either one of OH,

ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_9 is the same or different for each unit;

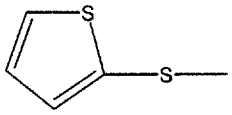
the chemical formula (13):



(13)

represents a 2-thienyl group;

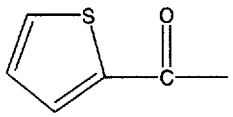
the chemical formula (14):



(14)

represents a 2-thienylsulfanyl group;

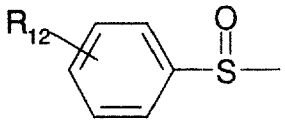
the chemical formula (15):



(15)

represents a 2-thienylcarbonyl group;

the chemical formula (16):

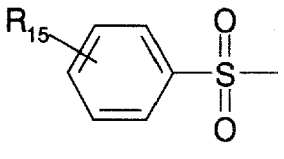


(16)

represents a group of substituted or non-substituted phenylsulfinyl groups in

which R_{12} represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_{13}$ group, a SO_2R_{14} group (R_{13} representing either one of H, Na, K, CH_3 and C_2H_5; and R_{14} representing either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_{12} is the same or different for each unit;

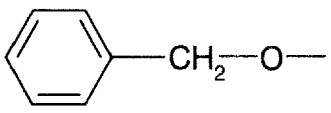
the chemical formula (17):



(17)

represents a group of substituted or non-substituted phenylsulfonyl groups in which R_{15} represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_{16}$ group, a SO_2R_{17} group (R_{16} representing either one of H, Na, K, CH_3 and C_2H_5; and R_{17} representing either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_{15} is the same or different for each unit; and

the chemical formula (18):



(18)

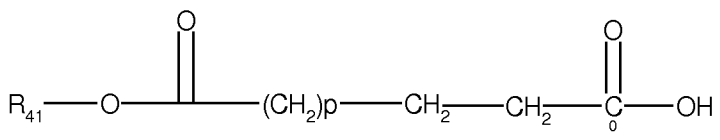
represents a (phenylmethyl)oxy group.

18. (Withdrawn) The producing method according to claim 14, wherein said oxidation reaction is carried out with an oxidant selected from a group consisting of a permanganate, a bichromate and a periodate.

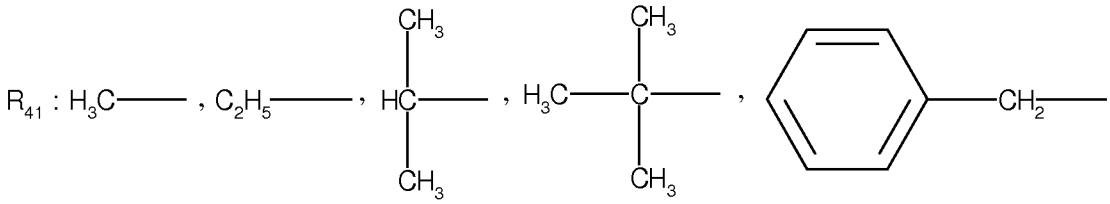
19. (Withdrawn) The producing method according to claim 18, wherein said oxidation reaction is carried out with a permanganate as an oxidant and under an acidic condition.

20. (Withdrawn) The producing method according to claim 14, wherein said oxidation reaction is carried out with ozone.

21. (Withdrawn) The method for producing a polyhydroxy alkanoate copolymer including a biosynthesis by a microorganism having an ability of producing a polyhydroxy alkanoate copolymer including at least a 3-hydroxy-ω-alkoxycarbonylalkanoic acid unit represented by a chemical formula (32) in a molecule, and simultaneously at least a 3-hydroxy-ω-alkanoic acid unit represented by a chemical formula (2) or a 3-hydroxy-ω-cyclohexylalkanoic acid unit represented by a chemical formula (3) in the molecule, from a dicarboxylic acid monoester compound represented by a chemical formula (42):

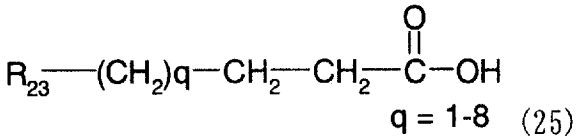


p = 1-8 (42)



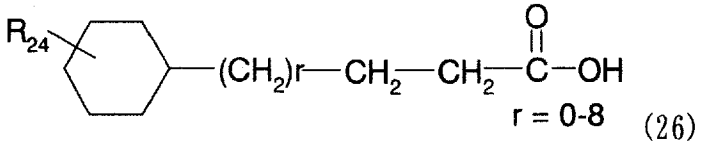
in which p may assume one or more arbitrary integral values within a range indicated in the chemical formula; and R_{41} may arbitrarily represent one or more residues indicated in the chemical formula; and at least a compound represented by a chemical formula (25) or at least a ω-cyclohexylalkanoic acid represented by a chemical formula (26) as starting materials:

[Chemical Formula (25)]



in which q represents an integer selected within a range indicated in the chemical formula; and R_{23} includes a residue having a phenyl structure or a thienyl structure;

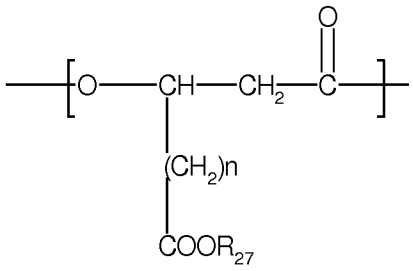
[Chemical Formula (26)]



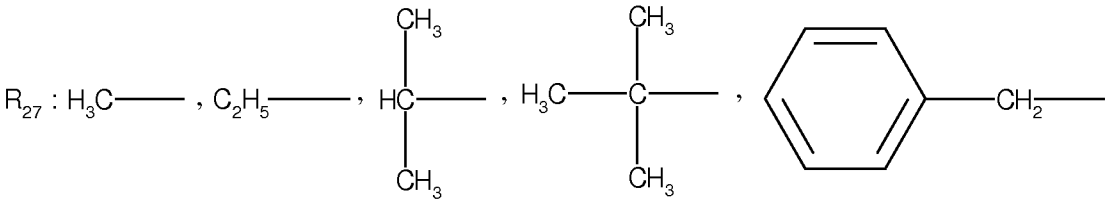
in which R_{24} represents a substituent on a cyclohexyl group and represents an H atom, a CN group, a NO_2 group, a halogen atom, a CH_3 group, a C_2H_5 group, a C_3H_7

group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and r represents an integer selected within a range indicated in the chemical formula;

[Chemical Formula (32)]

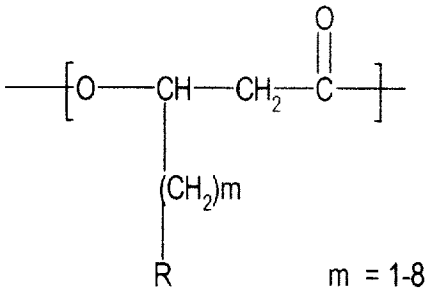


n = 1-8 (32)



in which n represents an integer selected within a range indicated in the chemical formula; R_{27} represents any of residues indicated in the chemical formula; and in case plural units are present, n and R_{27} are the same or different for each unit;

[Chemical Formula (2)]

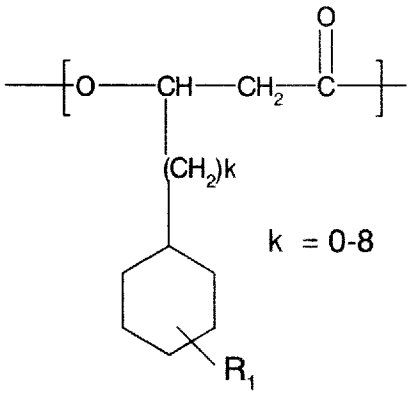


m = 1-8 (2)

in which m represents an integer selected within a range indicated in the

chemical formula; R represents a residue having any of a phenyl structure and a thienyl structure; and in case plural units are present, m and R are the same or different for each unit; and

[Chemical Formula (3)]

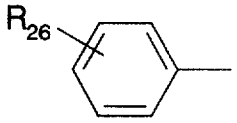


(3)

in which R_1 represents a substituent on a cyclohexyl group and represents an H atom, a CN group, a NO_2 group, a halogen atom, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; k represents an integer selected within a range indicated in the chemical formula; and in case plural units are present, R_1 and k are the same or different for each unit.

22. (Withdrawn) The method for producing a polyhydroxy alkanoate copolymer according to claim 21, wherein R_{23} in the chemical formula (25) and R in the chemical formula (2), each representing a residue having a phenyl structure or a thienyl structure, represents at least one of chemical formulas (31), (9), (10), (11), (12), (13), (14), (15), (16), (17) and (18):

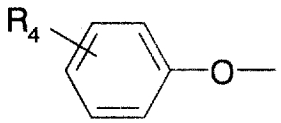
the chemical formula (31):



(31)

represents a group of substituted or non-substituted phenyl groups in which R_{26} represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $CH=CH_2$ group, a CF_3 group, a C_2F_5 group or a C_3F_7 group; and in case plural units are present, R_{26} is the same or different for each unit;

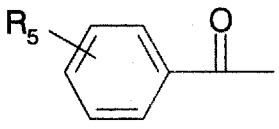
the chemical formula (9):



(9)

represents a group of non-substituted or substituted phenoxy groups in which R_4 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a SCH_3 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_4 is the same or different for each unit;

the chemical formula (10):

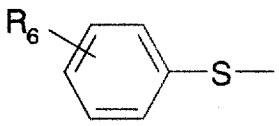


(10)

represents a group of non-substituted or substituted benzoyl groups in which R_5 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a

CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_5 is the same or different for each unit;

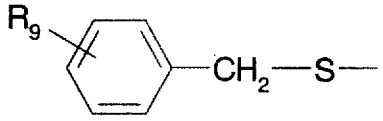
the chemical formula (11):



(11)

represents a group of substituted or non-substituted phenylsulfanyl groups in which R_6 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_7$ group, a SO_2R_8 group (R_7 representing either one of H, Na, K, CH_3 and C_2H_5; and R_8 representing either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_6 is the same or different for each unit;

the chemical formula (12):

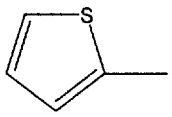


(12)

represents a group of substituted or non-substituted (phenylmethyl)sulfanyl groups in which R_9 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_{10}$ group, a SO_2R_{11} group (R_{10} representing either one of H, Na, K, CH_3 and C_2H_5; and R_{11} representing either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a

$(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_9 is the same or different for each unit;

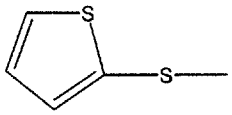
the chemical formula (13):



(13)

represents a 2-thienyl group;

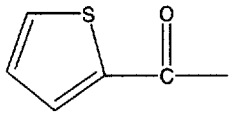
the chemical formula (14):



(14)

represents a 2-thienylsulfanyl group;

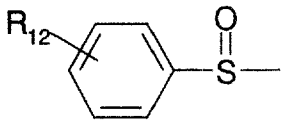
the chemical formula (15):



(15)

represents a 2-thienylcarbonyl group;

the chemical formula (16):

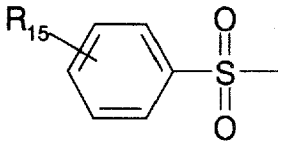


(16)

represents a group of substituted or non-substituted phenylsulfinyl groups in which R_{12} represents a substituent on an aromatic ring and represents an H atom, a halogen

atom, a CN group, a NO_2 group, a $COOR_{13}$ group, a SO_2R_{14} group (R_{13} representing either one of H, Na, K, CH_3 and C_2H_5; and R_{14} representing either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_{12} is the same or different for each unit;

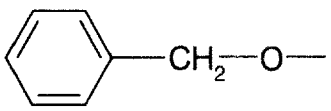
the chemical formula (17):



(17)

represents a group of substituted or non-substituted phenylsulfonyl groups in which R_{15} represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_{16}$ group, a SO_2R_{17} group (R_{16} representing either one of H, Na, K, CH_3 and C_2H_5; and R_{17} representing either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_{15} is the same or different for each unit; and

the chemical formula (18):



(18)

represents a (phenylmethyl)oxy group.

23. (Withdrawn) The method for producing a polyhydroxy alkanoate

copolymer according to claim 21, wherein the microorganism is cultured in a culture medium including at least a dicarboxylic acid monoester compound represented by the chemical formula (42) and at least a compound represented by the chemical formula (25) or at least an ω-cyclohexylalkanoic acid represented by the chemical formula (26).

24. (Withdrawn) The method for producing a polyhydroxy alkanoate copolymer according to claim 23, wherein the microorganism is cultured in a culture medium including, in addition, at least one of a peptide, an yeast extract, an organic acid or a salt thereof, an amino acid or a salt thereof, a sugar, a linear alkanoic acid with 4 to 12 carbon atoms or a salt thereof.

25. (Withdrawn) The method for producing a polyhydroxy alkanoate copolymer according to claim 21, characterized in including a step of recovering a polyhydroxy alkanoate copolymer, produced by said microorganism, from cells of the microorganism.

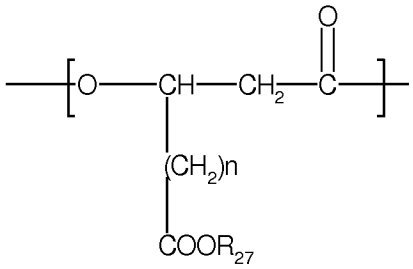
26. (Withdrawn) The method for producing a polyhydroxy alkanoate copolymer according to claim 21, wherein said microorganism is a microorganism belonging to *Pseudomonas* genus.

27. (Withdrawn) The method for producing a polyhydroxy alkanoate copolymer according to claim 26, wherein said microorganism is at least one of

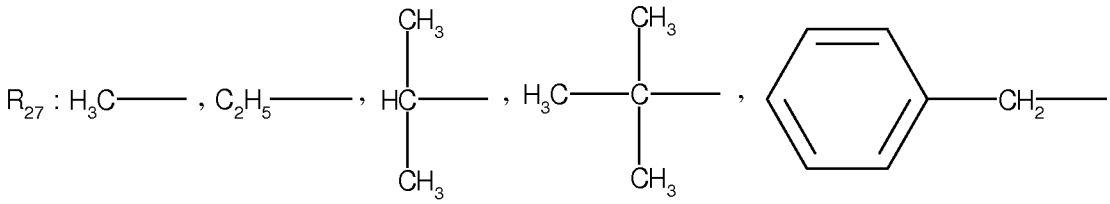
Pseudomonas cichorii YN2 strain (FERM BP-7375), *Pseudomonas cichorii* H45 strain (FERM BP-7374), *Pseudomonas jessenii* P161 (FERM BP-7376) and *Pseudomonas putida* P91 (FERM BP-7373).

28. (Withdrawn) A method for producing a polyhydroxy alkanoate copolymer, characterized in employing a polyhydroxy alkanoate copolymer including at least a 3-hydroxy-ω-alkoxycarbonylalkanoic acid unit represented by a chemical formula (32) in a molecule, and simultaneously at least a 3-hydroxy-ω-alkanoic acid unit represented by a chemical formula (2) or a 3-hydroxy-ω-cyclohexylalkanoic acid unit represented by a chemical formula (3) in the molecule as a starting material, and executing a hydrolysis in the presence of an acid or an alkali or executing a hydrogenolysis including a catalytic reduction, thereby generating a polyhydroxy alkanoate copolymer including at least a 3-hydroxy-ω-carboxyalkanoic acid unit represented by a chemical formula (19) in a molecule, and simultaneously at least a 3-hydroxy-ω-alkanoic acid unit represented by a chemical formula (2) or a 3-hydroxy-ω-cyclohexylalkanoic acid unit represented by a chemical formula (3) in the molecule:

[Chemical Formula (32)]

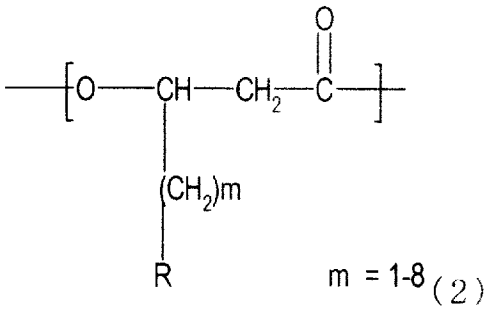


n = 1-8 (32)



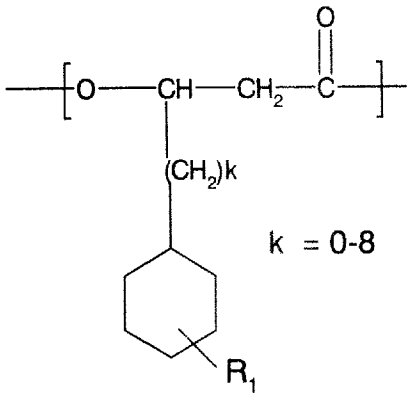
in which n represents an integer selected within a range indicated in the chemical formula; R_{27} represents any of residues indicated in the chemical formula; and in case plural units are present, n and R_{27} are the same or different for each unit;

[Chemical Formula (2)]



in which m represents an integer selected within a range indicated in the chemical formula; R includes a residue having any of a phenyl structure and a thienyl structure; and in case plural units are present, m and R are the same or different for each unit;

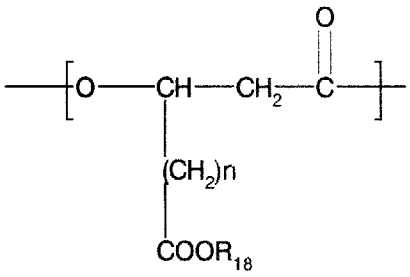
[Chemical Formula (3)]



(3)

in which R_1 represents a substituent on a cyclohexyl group and represents an H atom, a CN group, a NO_2 group, a halogen atom, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; k represents an integer selected within a range indicated in the chemical formula; and in case plural units are present, R_1 and k are the same or different for each unit; and

[Chemical Formula (19)]

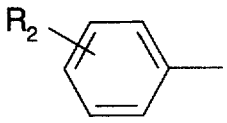


n = 1-8 (19)

in which n represents an integer selected within a range indicated in the chemical formula; R_{18} represents an H atom, a Na atom, or a K atom; and in case plural units are present, n and R_{18} are the same or different for each unit.

29. (Withdrawn) The method for producing a polyhydroxy alkanoate copolymer according to claim 28, wherein R in the chemical formula (2), representing a residue having a phenyl structure or a thienyl structure, represents at least one of chemical formulas (8), (9), (10), (11), (12), (13), (14), (15), (16), (17) and (18):

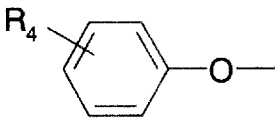
the chemical formula (8):



(8)

represents a group of non-substituted or substituted phenyl groups in which R_2 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $CH=CH_2$ group, a $COOR_3$ group (R_3 representing an H atom, a Na atom or a K atom), a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_2 is the same or different for each unit;

the chemical formula (9):

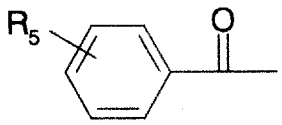


(9)

represents a group of non-substituted or substituted phenoxy groups in which R_4 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a SCH_3 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_4 is the

same or different for each unit;

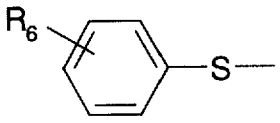
the chemical formula (10):



(10)

represents a group of non-substituted or substituted benzoyl groups in which R_5 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_5 is the same or different for each unit;

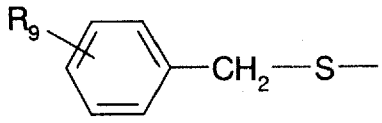
the chemical formula (11):



(11)

represents a group of substituted or non-substituted phenylsulfanyl groups in which R_6 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_7$ group, a SO_2R_8 group (R_7 represents either one of H, Na, K, CH_3 and C_2H_5; and R_8 represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_6 is the same or different for each unit;

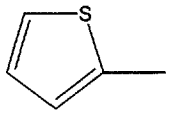
the chemical formula (12):



(12)

represents a group of substituted or non-substituted (phenylmethyl)sulfanyl groups in which R_9 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_{10}$ group, a SO_2R_{11} group (R_{10} represents either one of H, Na, K, CH_3 and C_2H_5; and R_{11} represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_9 is the same or different for each unit;

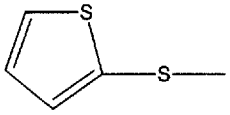
the chemical formula (13):



(13)

represents a 2-thienyl group;

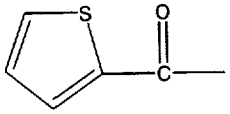
the chemical formula (14):



(14)

represents a 2-thienylsulfanyl group;

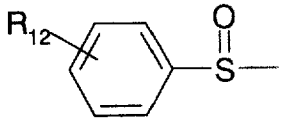
the chemical formula (15):



(15)

represents a 2-thienylcarbonyl group;

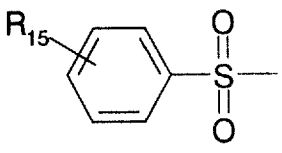
the chemical formula (16):



(16)

represents a group of substituted or non-substituted phenylsulfinyl groups in which R_{12} represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_{13}$ group, a SO_2R_{14} group (R_{13} represents either one of H, Na, K, CH_3 and C_2H_5; and R_{14} represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_{12} is the same or different for each unit;

the chemical formula (17):

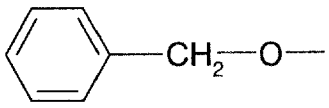


(17)

represents a group of substituted or non-substituted phenylsulfonyl groups in which R_{15} represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_{16}$ group, a SO_2R_{17} group (R_{16} represents either one of H, Na, K, CH_3 and C_2H_5; and R_{17} represents either one of OH, ONa, OK, a

halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2$-CH group or a $(CH_3)_3$-C group; and in case plural units are present, R_{15} is the same or different for each unit; and

the chemical formula (18):



(18)

represents a (phenylmethyl)oxy group.